the mouth or pharynx, the cellulitis may extend into the mediastinum and so cause a septic pneumonia. The effect on the patient is that of a virulent septic infection, plus the interference with the function of the parts involved,—speech, deglutition, respiration—plus, also, the infection of larynx and lungs. Death may come in a few hours from overwhelming sepsis, or later from interference with nutrition and more particularly respiration (edema glottidis), or later yet from septic pneumonia, and it may even occur when the patient is seemingly convalescent, and then is apparently by heart failure.

In Thomas's careful paper (An. Surg., 1908, p. 169), he reports 106 cases, observed or collected; in ninety-two the swelling began external to the mouth and pharynx, and in sixty-one of them it was first noticed in the sub-maxillary region.

Incision in this region, parallel to the border of the mandible, is of prime importance, though a mesial incision from the jaw to the hyoid quite through into the mouth has been advised and practised. The incision must go through the deep fascia or to pus. If it is made early only serum may be found, and gangrenous cellular tissue.

After the supervention of edema of the larynx, tracheotomy will be of very doubtful value, as the trachea would be opened directly into an infected area.

There has been much discussion regarding the keeping of the name "Ludwig's Angina." In 1895 Felix Simon, St. Thomas, London, claimed that acute edema of the larynx—edematous laryngitis—erysipelas of pharynx and larynx—phlegmon of pharynx and larynx and angina ludovici, were all the same thing. This seems to me to be too sweeping a statement, for laryngeal and pharyngeal infection may occur without the cellulitis, or cellulitis may not lead to the infection of the larynx and pharynx.

Thomas advises the keeping of the name, as indicating a fairly well defined lesion, which is said to be not so rare as my experience would make it.

THE EPIDEMIOLOGY AND CONTROL OF RABIES.*

By W. A. SAWYER, M. D.,
Director of the Hygienic Laboratory of the California State Board of Health.

Rabies is a serious and expensive disease which can easily be prevented by the communities involved. A knowledge of its epidemiology is the only reasonable basis for determining the necessary preventive measures.

Epidemics of rabies display certain features which are explained by the characteristics the disease shows in the individual case. For one thing, there are no prolonged cases or chronic carriers to harbor and spread the disease over long periods of time, as rabies is almost invariably fatal after an illness of from two to ten days, usually five or six. The diseased animal as a rule spreads the infection only during the few days of evident symptoms, although there is a possibility of transmitting the disease from two to eight days earlier. From this it would appear that an epidemic could be promptly and effectively suppressed if the acute cases could be controlled over a period of a very few weeks. This would be true if it were not for another striking characteristic of rabies—its long incubation period. An interval of complete absence of symptoms occurs between the inoculation and the appearance of the disease. This interval is seldom less than two weeks, usually from one to three months, and in rare instances six months or over. The long incubation period separates succeeding generations of the disease, leading the public to feel that the outbreak is confined to the few early cases, when in reality the disease may be slumbering and preparing to break out in a formidable epidemic.

The third important characteristic of rabies from the standpoint of epidemiology is its transmission only through inoculation, and almost entirely through the bites of the diseased animals. This means that the disease can be absolutely interrupted in a period of time determined by the incubation period, if the infected animals can be prevented from biting. The method of transmission of the disease would not explain its perpetuation and extensive distribution if a tendency to snap and bite were not an early prominent symptom in many of the canine cases.

These three characteristics of rabies—the long incubation period, the short period of infectivity terminated by death, and the transmission by bites only—permit a rough prediction of the course of an epidemic and the formation of a reasonable plan for the control of the outbreak. A more accurate prediction, however, can be based on the study of previous epidemics as a whole.

In California we are having an unusual opportunity for studying the epidemiology of rabies. The disease a few years ago made its first entrance into the state, and it has appeared in one community after another, showing its manner of invasion and development in previously uninvaded fields. The courses of these initial epidemics show certain characteristics which permit of generalization and are therefore worthy of special attention.

In the accompanying chart the incidence of cases by months has been shown for several important divisions of California. The curves represent laboratory examinations of the heads of animals with resulting positive diagnoses of rabies. The curves show only a small part of the total

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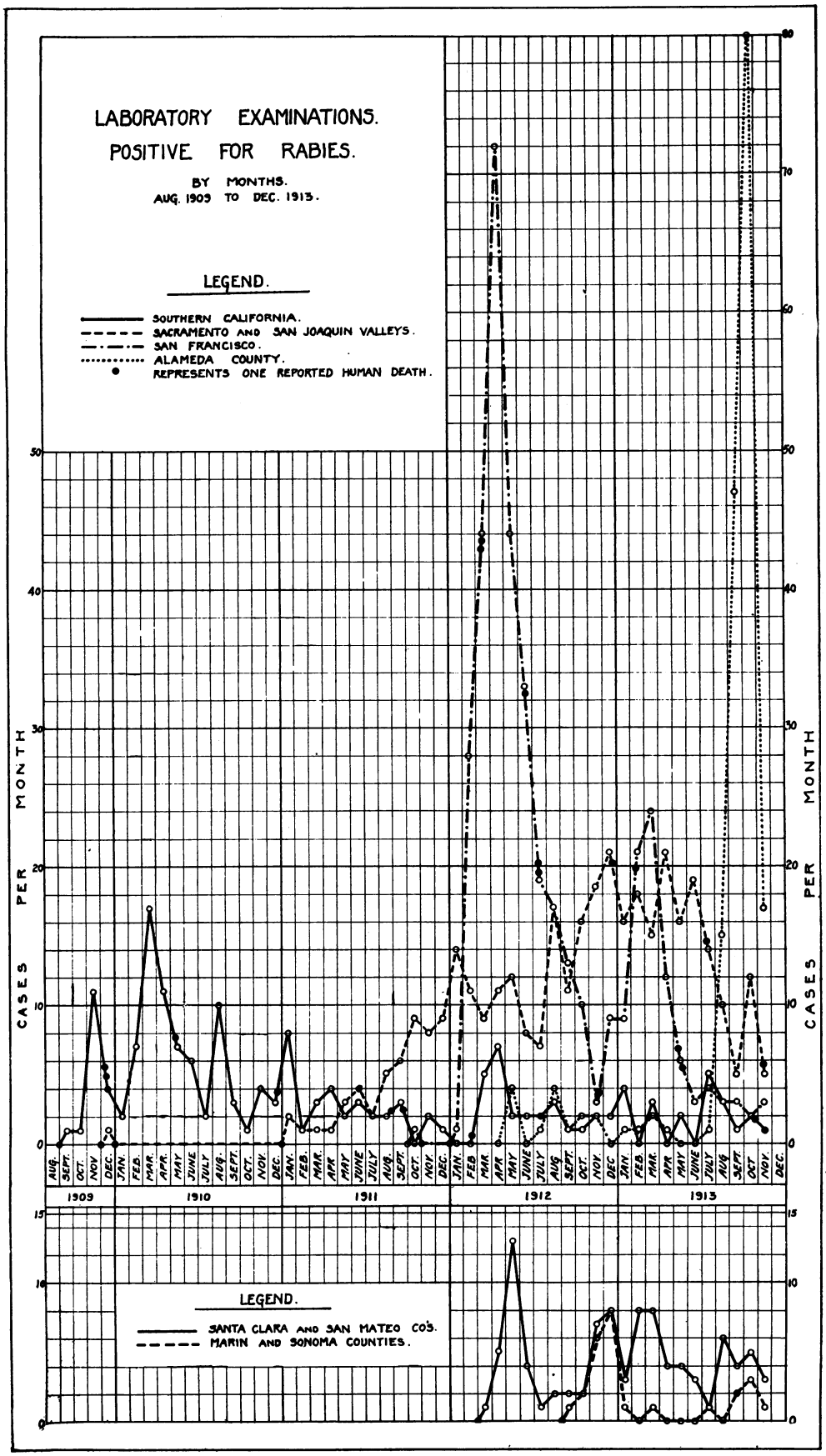
LABORATORY EXAMINATIONS.
POSITIVE FOR RABIES.
BY MONTHS.
AUG. 1909 TO DEC. 1913.
LEGEND.
SOUTHERN CALIFORNIA.
SACRAMENTO AND SAN JOAQUIN VALLEYS.
SAN FRANCISCO.
ALAMEDA COUNTY.
REPRESENTS ONE REPORTED HUMAN DEATH.
CASES PER MONTH
AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1909
1910
1911
1912
1913
LEGEND.
SANTA CLARA AND SAN MATEO COS.
MARIN AND SONOMA COUNTIES.

number of cases in the state. Certain portions of California are omitted in order to avoid confusion from too much repetition. The chart, being based on laboratory findings, does not show the large number of rabid animals whose heads were not sent for laboratory diagnosis. A considerable number of examinations have been made by laboratories whose reports were not readily available for the entire period and were therefore not included. Although the curves represent only a small part of the cases, the shapes of the curves are nevertheless probably a fair indication of the fluctuations of the epidemics.

In making these curves the statistics of the following laboratories were used: The Hygienic Laboratory of the California State Board of Health and the laboratories of the Health Departments of Los Angeles, San Francisco, Sacramento, and Oakland. Small solid circles added to the curves each represent one reported human death from rabies within the area under consideration, and during the month indicated on the chart.

A few cases of the disease were reported in Southern California before the earliest dates shown by the laboratory records. The curve representing Southern California begins in September, 1909, and shows a sharp rise in November, representing chiefly cases in Pasadena. The next two peaks in the curve coincide with the prevalence of the disease in Los Angeles in 1910. The peak in January, 1911, was caused principally by cases in Riverside. Since then the disease in Southern California has apparently become endemic, with a decreased number of cases in animals and man. The moderate increase in February and March of 1912 occurred in Los Angeles.

The second curve represents the San Joaquin and Sacramento valleys. The first case shown occurred in December of 1909 in Stockton and represents a circumscribed outbreak which showed little tendency to spread. In January, 1911, cases were discovered in the southern end of the San Joaquin Valley. Apparently the sparsely settled mountainous region between the San Joaquin Valley and Southern California had greatly retarded the extension of the disease northward in spite of the railroad traffic through this region. The disease spread rapidly through the thickly populated farming country on the east side of the valley. The summit of the curve in January, 1912, represents the height of the disease in Fresno, Kings and Tulare counties. The increase in cases from August, 1912, to March, 1913, was in part due to cases in recently involved communities in the northern end of the San Joaquin Valley, but largely to the passage of the epidemic northward into the Sacramento Valley, involving many towns and the City of Sacramento. Now that the disease had invaded the most populous portions of both valleys, it began to decrease. This curve representing many communities is much more gradual in its changes than the curves representing single cities.

In October, 1911, the first case was discovered in San Francisco. In February of the following year the epidemic developed suddenly and in April it reached its maximum. This is an excellent example of the rapid spread of a disease in a region previously uninvolved. The fall was almost equally rapid and was undoubtedly greatly influenced by the measures instituted by the city against the disease. A recrudenscence occurred a year later. Since then the number of cases has been small compared to those in neighboring communities.

San Francisco is surrounded by cities and towns, and there is a great deal of travel between them. On all sides but one the traveling is done by ferry and the egress of dogs in these directions is therefore less than if there were no water barrier. The fourth curve shows how the disease spread up the peninsula over the land boundary from San Francisco into San Mateo and Santa Clara counties. There was nothing to prevent dogs from traveling in this direction in considerable numbers, causing repeated invasions of the disease and a correspondingly early and sudden epidemic. The peak of the curve was reached in May, 1912, and was due to the involvement of South San Francisco, San Mateo, Palo Alto and the intervening country. The subsequent rises in the curve represent increases of the disease in the same region.

In all other directions from San Francisco the bay formed a natural barrier and the disease was late in getting a start, although there was much travel over the ferries. In Alameda County, with its population of over 200,000 people, scattering cases appeared in May, 1912, but for three months the disease showed little tendency to reach epidemic proportions in spite of the lack of adequate attempts at control. Suddenly, in August, 1913, this mild outbreak took on the proportions of an epidemic in Oakland, and to a less extent in Berkeley. The maximum was reached in October. Vigorous steps were then taken, greatly aided by the publicity given the situation by the press, and the epidemic very suddenly decreased. The large number of persons and valuable dogs bitten aroused public sentiment and made it possible to suppress the disease. It is needless to say that the outbreak should have been anticipated and prevented, as Oakland and Berkeley had the advantage of observing the experience in San Francisco.

The sixth and last curve of our chart represents Marin and Sonoma counties, north of San Francisco Bay. The disease did not get a good start in these counties until eight months after it became prevalent in the neighboring city of San Francisco, although there is constant travel over the ferries. The maximum of cases was apparently reached in December, 1912.

The cases in human beings are coincident in each area with the presence of the disease among dogs. They represent part of the toll exacted by rabies from communities which permit the disease to exist. Other penalties are the subjection of a much larger number of persons to the expense of the Pasteur preventive treatment, and the loss of valuable domestic animals, including horses, cows, pigs, goats and dogs.

The California experience with rabies leads to several generalizations regarding its epidemiology:

1. When a separate populous community is invaded for the first time there are usually a few scattered cases in dogs, during a period of several months, followed by a sharp epidemic. The subsidence of this epidemic is apt to be rapid, although less rapid than the rise. The fall in the number of cases is partly due to measures taken to suppress the disease and partly to a tendency of the epidemic to spend itself. After the rapid fall, rabies usually becomes endemic in the community and the number of cases is small and fluctuates in an irregular way.

The manner in which an epidemic of rabies partially spends itself is a matter of conjecture. Probably this natural decrease in the number of cases depends upon the death through rabies of a considerable number of those dogs which are most likely to become infected owing to unusual susceptibility, or to special vulnerability due to lack of skill in fighting or short hair, habits of roaming the streets, and lack of discretion in approaching and attacking other dogs. Acquired immunity can scarcely play a part, as the disease when once developed is fatal, and we have no reason to suppose that immunity is produced in nature by rare accidental inoculation of virus too small in amount to produce symptoms.

2. A community contiguous to a heavily infected area, and freely communicating with it, is apt to be plunged suddenly into an epidemic without the preliminary scattering cases. This is probably due to multiple invasion instead of the entrance of a very few cases.

3. A community separated from a nearby heavily infected area by a barrier, such as a mountain, a body of water, or a thinly populated region, even if a large number of people and a considerable number of dogs cross the barrier daily, may escape all but a few scattered cases for many months, but is apt ultimately to have a severe epidemic. The spread of the disease from Southern California over the mountains to the San Joaquin Valley and from San Francisco across the bay to Alameda County and to Marin and Sonoma counties furnishes examples.

4. Areas made up of many separate communities show a more gradual rise and fall in the aggregate number of cases than do single cities. Compare the curves for the San Joaquin and Sacramento valleys with those for San Francisco and Alameda County.

5. The severe epidemics show no predilection for hot and dry months, nor for any particular season. In fact, the Los Angeles and San Francisco outbreaks reached their maxima in March, a cool season with abundant moisture.

6. The presence of an epidemic of rabies in dogs is almost sure to result in a few human deaths. Note the deaths in San Francisco and Southern California in spite of opportunity for receiving the Pasteur treatment, privately, or without charge from the state. It is impossible to bring all persons bitten under treatment.

7. The spread of an epidemic of rabies in new territory is slow and steady, as if the principal factor were the carrying of the disease by a considerable number of dogs traveling out from the edge of the involved territory on foot. While dogs in the incubation period are taken at times over long distances by railroad, or automobile, or boat, this does not seem to have been the chief method of spread in California. The more dogs passing out of the infected area, the better is the chance that some of them will be in the acute or incubation stages of rabies and that part of these will have the disease in the more dangerous furious type and will inoculate many animals. That the progress is slow and steady is illustrated by the fact that it took over a century for rabies to cross the continent to the Pacific Coast, and over three years for the steady march of the epidemic from the southern to the northern end of California.

CONTROL.

If the California epidemic of rabies was so steady in its spread that each community could anticipate its arrival, why were not the well-known and effective measures of control applied to prevent the involvement of the great central valleys and the large cities? It is true that the course of the epidemic was well known and was freely predicted by the State Board of Health, and advice was given regarding the best methods of control. While this was helpful in keeping down the number of cases in special communities, the effect on the situation as a whole was slight. It takes so long to get special action against disease in our American towns and cities that the disease usually becomes established before action is taken, and the epidemic is only palliated, not prevented. Then, too, the measures are usually applied in a half-hearted, ineffective manner which keeps down the number of cases without stopping the outbreak. The more successful the control the less apparent is the need for it, and as public support lessens the action of the authorities becomes more difficult and less effective. The usual experience in California was, therefore, no action until the disease appeared, much discussion and half-hearted action during the critical period when the early scattered cases were discovered, fairly effective control when the disease was at its height, and a relaxation of effort as soon as the epidemic had diminished. Under even these circumstances the results would have been much better had it not been for two factors which acted specially to prevent the eradication of the disease in communities. In the first place, measures were usually discontinued in less than six months after the last known case, usually within a few weeks. This was due to a failure

of the authorities and the public to appreciate the full significance of the long incubation period.

The second of these important factors is that the attempts at control involved areas so small that even complete eradication of the disease would be followed by reinvasion from the surrounding country. To overcome this difficulty the State Legislature in 1913 enacted a law putting the direction of the control of rabies under the State Board of Health and compelling local authorities to carry out the provisions of the act. As rabies is a disease of large areas it should be fought by concerted action under the direction of a central authority.

The methods of control which have been found efficient are essentially as follows, and will be found embodied in the regulations of the State Board of Health:

1. All cases of rabies should be promptly reported to the local health authority for investigation and action.

2. Animals under suspicion of having rabies and all dogs which bite human beings should be taken up and confined separately under observation for a minimum period of ten days. These animals should not be left at their homes as they often bite the people who care for them, and not infrequently escape.

3. Dogs which have been bitten by rabid animals should be killed if their value is not sufficient to warrant their being immunized. Confining such animals under observation for two or three weeks does not give protection, as the incubation period is usually longer than that and is often several months in duration.

4. When persons have been bitten by rabid animals the wounds should be cauterized at once, preferably with nitric acid. Then the animal should be captured and kept under observation for ten days. It is not good advice to recommend the killing of the dog so that its brain can be examined. If the dog is killed and the microscopical examination is negative, the diagnosis is still in doubt. On the other hand, if the dog is kept alive a provisional diagnosis can usually be made within twenty-four or forty-eight hours, and if the animal remains well for ten days, rabies is disproved.

5. If a dog which has bitten a person has been killed or has died under observation, the head should he removed and sent to a municipal or state laboratory for examination. The Hygienic Laboratory of the California State Board of Health from the beginning of the epidemic in 1909 up to December 1, 1913, made 758 examinations for rabies with positive results in 613 cases.

6. If a person has been bitten by a rabid animal so that the skin is broken, or if the saliva of a rabid animal has entered a fresh break in the skin, the Pasteur preventive treatment should be administered as soon as possible. Provision for this has been made in California by the State Board of Health, which administers the treatment free at eight laboratories. This treatment is available to persons who are unable to pay the cost of antirabic treatment without undue hardship and who bring the recommendation of the local health officer. Persons who are able to pay for the trtatment are expected to procure it from their physicians, who can purchase the virus from commercial biological laboratories. The State Hygienic Laboratory has maufactured and administered treatment to 322 persons in the seventeen months preceding December 1, 1913, and previous to that time it administered virus from the Hygienic Laboratory at Washington, D. C., to 103 persons. The Cutter Laboratory kindly furnished us the information that they had sold treatment for 207 persons in California during the twelve and one-half months before December 1, 1913. When we consider that other firms are selling virus in California, we can see that the number of persons bitten by animals known to have rabies, or suspected of it, has been large. This indicates the necessity for adequate measures against the disease.

7. On the first appearance of rabies in a community measures should be instituted to protect the public and to eradicate the disease. These should include the destruction of all ownerless dogs, diminution in the number of dogs through a license tax, the muzzling of all dogs free on the streets, adequate facilities for taking up, impounding, isolating, observing and destroying dogs, investigation of all reported cases by someone competent to give advice regarding treatment and the destruction of animals which have been bitten, arrangement through the State Board of Health for the institution of measures in neighboring areas, and, if necessary, quarantine against dogs.

In closing, I wish to protest against the shooting of dogs on the street, except in emergencies where there is an actual and immediate danger. With suitable provisions for a pound, dog-catchers and wagons, there is no need for noise and disorder and bloodshed in the suppression of rabies.

In all cases the measures should be based upon a thorough knowledge of rabies and its epidemiology, and special pains should be taken to spread such knowledge among the general public.

A POSITIVE READING MANOMETER FOR THERAPEUTIC PNEUMOTHORAX.

By EDWARD VON ADELUNG, M. D., Oakland.

Artificial, or therapeutic, pneumothorax cannot be safely done without careful guidance by the manometer. The reading of this gauge is of prime importance. As is well known, the fluid in the manometer is in constant motion because the intrathoracic pressure is constantly changing, due to the patient's breathing. Some operators record maximum readings, and some record minimum readings. Both of these figures vary more than the figure that represents the *mean* pressure. I am therefore here advocating the recording of *mean* pressures as more accurate.

I wish to call attention to a simple attachment for the manometer, attachable to any form of manometer. Its use secures a non-oscillating mean pressure registration.

The device is shown in Figure 1. A capillary